

**BLACKSTONE RIVER BASIN
WORCESTER, MASSACHUSETTS**

**COOK POND DAM
MA 00123**

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

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**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
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Cook Pond Dam is an earthfill dam. The dam has a maximum height of 15 feet and is approximately 510 feet long. The dam is considered to be in fair to poor condition. It has been classified in the "high" hazard category. The test flood for the dam is one-half the PMF.			

COOK POND DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
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PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00123

Name of Dam: Cook Pond

Town: Worcester

County and State: Worcester County, Massachusetts

Stream: Tributary of Blackstone River

Date of Inspection: July 10, 1978

Cook Pond Dam is an earthfill dam built about 1830. The dam has a maximum height of 15 feet and is approximately 510 feet long. The main spillway is located near the west abutment and is made of dry stone masonry and concrete. The weir is 37.7 feet long and the crest of the weir is 11.6 feet wide. Normal discharge flows over the weir, down a dry-stone cascade, and into the stream bed. There is an emergency spillway excavated in natural ground and located about 100 feet east of the left dam abutment. The emergency spillway is 470 feet long, with a trapezoidal section having a bottom width of 13 feet, and a height of 5 to 8 feet. It joins the stream 100 feet below the main spillway. There is also an outlet conduit beneath the dam embankment, 4 feet east of the spillway. The conduit is a 12-inch-diameter, cast-iron pipe and is about 45 feet long. Flow is controlled by a gate valve operated by a hand wheel and enclosed in a corrugated metal housing just upstream of the spillway. The only plans, specifications, or computations available from the Owner, State, or County offices on the design, construction, or repairs to this dam are an undated sketch of the spillway and a drawing dated 1958 of the reconstruction of the gate valve housing.

Due to its age, Cook Pond Dam was neither designed nor constructed by current approved state-of-art procedures. Based upon the visual inspection at the site, the lack of engineering data available, and limited operational or maintenance evidence, there are areas of concern which must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in fair to poor condition. Cook Pond Dam has been classified in the "high" hazard category.

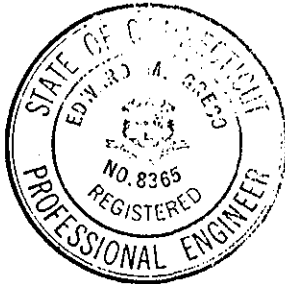
There are several visible signs of distress which indicate a potential hazard at the site: seepage at the toe of the dam, buried outlet of the outlet conduit, steep embankment slopes near the spillway, severe erosion of the spillway weir and pier, heavy growth of trees and brush on the dam embankment and downstream areas, erosion and lack of riprap on the upstream face of the dam, stonework missing from the west spillway sidewall and cascade, and wood/trash debris in the downstream stream bed.

Hydraulic analyses indicate that the main spillway can discharge a flow of 693 cubic feet per second (cfs) and the emergency spillway can discharge a flow of 144 cfs at Elevation (El) 609.5 which is the approximate average dam crest. The lowest point on the dam crest is El 608.6 which is a localized erosion area near the spillway. Based on size and hazard classification, in accordance with Corps guidelines, a test flood of one-half Probable Maximum Flood (1/2 PMF) was utilized. An inflow test flood of 6,390 cfs will overtop the main dam by about 2.3 feet. The two spillways are considered inadequate because combined they discharge only 13 percent of the adjusted outflow test flood of 6,230 cfs. In the event of overtopping, complete failure of the dam could occur. Due to the potential for overtopping, it is recommended that a definite plan for surveillance and a warning system be developed for use during periods of unusually heavy rains and/or runoff. This system should be coordinated with the Owner of the dam.

It is recommended that the Owner employ a qualified consultant to evaluate the stability of the dam and seepage at the toe of the dam and to conduct a more detailed hydrologic and hydraulic investigation in order to evaluate the spillway and outlet capacities. It is also recommended that the Owner repair the concrete on the spillway weir and pier,

remove the blockage at the outlet pipe, clear trees and brush from the embankment and downstream areas, repair erosion on the upstream face of the dam and protect the slope with riprap, replace missing stonework from the west spillway wall and cascade, and clear debris from the stream bed below the main spillway. The Owner should also implement a systematic program of inspection and maintenance.

The above recommendations should be implemented within a period of 1 year after receipt of the Phase I Inspection Report. An alternative to these recommendations would be draining the reservoir and breaching or removing the dam.



A handwritten signature in cursive script, reading "Edward M. Greco".

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Stephen L. Bishop, P.E.
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This Phase I Inspection Report on Cook Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and
Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL C. COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

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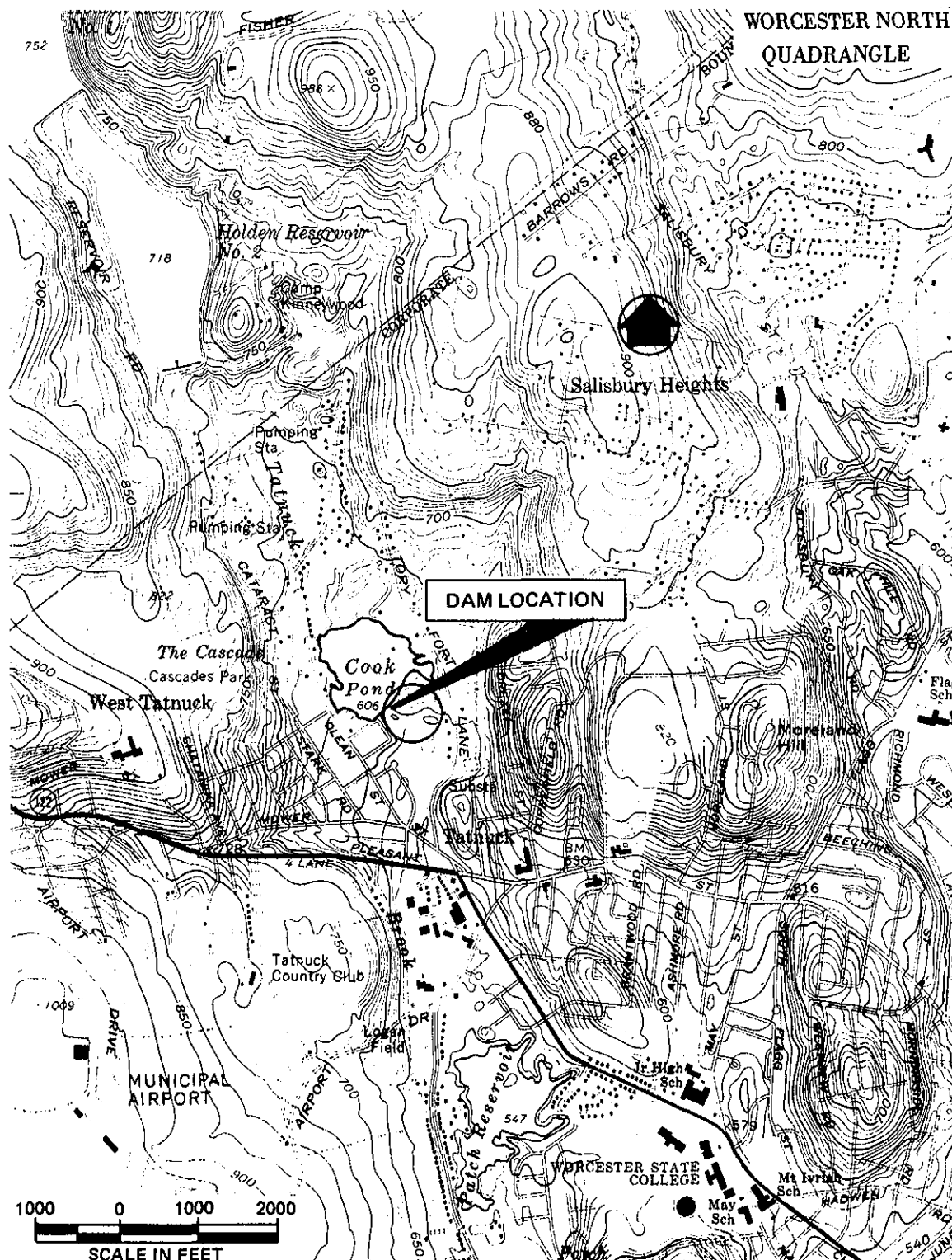
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**OVERVIEW
COOK POND DAM
WORCESTER, MASSACHUSETTS**



DAM CREST AND SPILLWAY

LOCATION AND DIRECTION OF
PHOTOGRAPHS SHOWN ON
FIGURE B-1 OF APPENDIX B



NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

COOK POND

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Metcalf & Eddy, Inc. under a letter of May 3, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0306 has been assigned by the Corps of Engineers for this work.
- b. Purpose:
 - (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
 - (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
 - (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

- a. Location. The dam is located in the City of Worcester, Worcester County, Massachusetts, on Tatnuck Brook, a tributary of the Blackstone River. See Location Map, Map of Drainage Area Figure D-2, and Watershed Plan Figure D-1..
- b. Description of Dam and Appurtenances. Cook Pond Dam is an earthfill dam, 510 feet long and 15 feet high (see Plan of Dam and Sections in Appendix B). The dam crest, which is a foot-path, is generally 7 to 12 feet wide except in a fill area west of the main spillway, where the width is 86 feet. The elevation of the crest varies from 608.6 to 609.7. The upstream and downstream slopes vary from 1:1 to 4:1. The slopes are covered with grass, brush, and trees. There is an 8-foot long, dry-stone masonry wall along the downstream edge of the dam crest adjacent to the east wall of the spillway.

The main spillway is located 200 feet east of the west abutment. It is a flat broad-crested weir constructed of dry-stone masonry that has been covered with reinforced concrete. The crest is 37.7 feet long. There is a raised edge 1.1-foot wide along the upstream weir. It has a top elevation of 606. There is a wooden walkway over the crest which is supported by a 3.7-foot thick concrete pier located near the middle of the weir (see photograph in Appendix C). The sidewalls are about 17 feet long and 2.0 (west side) to 2.8 (east side) feet thick. Discharge flows over the weir, down a stone cascade and into a stream bed.

There is an emergency spillway located about 100 feet east of the east abutment. The spillway is an unlined trapezoidal section excavated in natural ground. It is about 470 feet long and curves around to the south and west to intersect the stream bed at about 100 feet

downstream of the spillway cascade. The invert elevation varies from 606.2 near the upstream end to 592.2 at the downstream end. The average bottom width is 13 feet, with side slopes of 1.3:1 to 1.4:1.

There is an outlet conduit located just east of the main spillway. The gate valve to the conduit was not operated during the inspection, and the conduit was not visible. A 1958 drawing (see Figure B-2 in Appendix B) indicates that it is a 12-inch diameter cast-iron pipe located 4 feet east of the main spillway. The invert of the conduit is estimated from the drawing to be 595.3 feet. The drawing shows a gate valve which is operated by a hand wheel and controls the flow into the conduit. The valve and wheel mechanism are enclosed in a circular, corrugated metal housing which is 4 feet in diameter. A metal cover is welded to the top of the housing and is secured by padlocks. The housing is located 8.5 feet upstream of the east wall of the spillway. A 6-inch wide metal plank provides access out to the housing from the spillway wall.

The downstream end of the conduit which is at the toe of the dam was not visible.

- c. Size Classification. Cook Pond Dam is classified in the "small" category, since it has a maximum height of 15 feet and a maximum storage capacity of 150 acre-feet.
- d. Hazard Classification. Highly developed residential areas of Worcester are located 0.2 miles downstream of the dam. Two well-traveled roadways also cross the stream at 0.3 and 0.4 miles below the dam. In the event of dam failure, numerous lives could be lost, and appreciable property damage could occur. Accordingly, the dam has been placed in the "high" hazard category.

- e. Ownership. The dam is presently owned by Smith Pond, Inc., which is an association of local property owners. The association president, Mr. James Thurston (617-752-4505) granted permission to enter the dam and to inspect the property.
- f. Operator. The Owner is the only operator of the dam, and has possession of keys to open the gate valve housing.
- g. Purpose of Dam. The dam was originally built as a storage pond for a grist mill. There is no available information as to the length of time it was used for that purpose. The dam was purchased by Smith Pond, Inc. in the early 1930's. Since that time it has been used for recreational purposes.
- h. Design and Construction History. Mr. Wallace Lindquist, retired engineer of the Worcester County Engineer's office, stated that Cook Pond dam was built around 1830 and was used as a storage reservoir for a grist mill. The Owner, however, believes the dam was built about 1900 and used as a water supply for Smith Woolen Mill which used to be located near Tatnuck Square. The dam was purchased from Frank Smith in the early 1930's by Smith Pond, Inc., an association of local property owners.

It was reported by the Owner and reports from the Worcester County Engineer's office that during the flood of 1938, overtopping of the dam occurred causing damage to the embankment. Subsequently, repairs were made to the embankment and the section west of the main spillway was partially removed, refilled, and widened. Also, the emergency spillway was constructed at that time. In 1958, the wooden gatehouse located upstream of the spillway was burned down, and the present corrugated metal housing was built at the same location. About three years ago, the Owner cleared the brush from the emergency spillway.

The only plans, specifications, or computations available from the Owner, State, or County offices on the design and construction of this dam are: an undated sketch of the spillway plan and sections showing no measurements or elevations, and a drawing dated 1958 showing the proposed reconstruction of the gate valve housing (copies included in Appendix B). A note on the list of past inspections at the Worcester County Engineer's office (see page B-5 in Appendix B) reports the 1938 flood elevation was 610.2.

- i. Normal Operational Procedure. There are no normal operating procedures at this dam. The only apparent outlet control is a 12-inch diameter cast-iron pipe located just east of the main spillway. Flow is controlled by a gate valve located in a corrugated metal housing just upstream of the dam. The Owner stated that the gate is operated periodically, although the last time was about four years ago.

The main spillway and emergency spillway are ungated and flows are unrestricted.

1.3 Pertinent Data

- a. Drainage Area. The approximately 4,531-acre (7.1 square mile) drainage area above the dam consists of sparsely developed, heavily wooded, and gently rolling land. The drainage area includes the watersheds for two Worcester County water supply reservoirs, Holden No. 1 and Holden No. 2. Discharge (see Figure D-2 in Appendix D) is to Tatnuck Brook which flows past Tatnuck Square about 2,200 feet downstream and into Patch Reservoir about 5,000 feet downstream. Cook Pond is one of a series of six dams located on Tatnuck Brook which eventually joins other tributaries of the Blackstone River at Webster Square in Worcester. (See Figure D-1 in Appendix D.)

- b. Discharge at the Dam Site. Normal discharge at the dam site is through the main spillway which is 37.7 feet long. It has a maximum crest elevation of 606.0, although flow is currently passing over eroded areas of the weir at El 605.5. The discharge flows down a stonework cascade into a stream bed about 35-feet wide. The elevation of the stream bed below the dam is about 594 and slopes very gently downstream. The bed is naturally lined with boulders and cobbles.

For pond elevations above El 606.2, discharge also flows through the emergency spillway located about 100 feet east of the left abutment. The spillway is a trapezoidal section with a bottom width of 13 feet, a height of 5 to 8 feet, and side slopes of about 1:1. The invert elevation ranges from 606.2 near the upstream end to 592.2 at the downstream end. The emergency spillway channel is 470 feet long and joins the stream below the dam about 100 feet from the spillway cascade. Water flows regularly through the emergency spillway, especially during periods of high runoff and when the reservoirs upstream are discharging surplus water.

Hydraulic analyses indicate that the main spillway can discharge an estimated 693 cfs and the emergency spillway an estimated 144 cfs at El 609.5 which is the approximate average dam crest. The lowest point on the dam crest is El 608.6 which is a localized erosion area near the spillway. An inflow test flood of 6,390 cfs (half of the probable maximum flood) will overtop the main dam by about 2.3 feet. There are no records of overtopping at the dam since the emergency spillway was constructed. The list of past inspections from the Worcester County Engineer's office notes that the flood elevation in 1938 was 610.2 (approximately 940 cfs), which is 0.7 to 1.6 feet above the dam crest.

Controlled discharge from the dam is through a 12-inch diameter outlet conduit located 4 feet east of the main spillway. The upstream invert is estimated to be 595.3 feet. The flow is controlled by a gate valve operated by a hand wheel. The conduit is about 45 feet long and outlets at the toe of the dam.

c. Elevation (feet above Mean Sea Level (MSL)). A benchmark elevation of 606.0 at the spillway crest was estimated from a U.S.G.S. topographic map.

- (1) Top dam 608.6 to 609.7
- (2) Test flood pool: 611.8
- (3) Design surcharge (original design):
unknown
- (4) Full flood control pool: Not Applicable
(N/A)
- (5) Recreation pool: 606.0
- (6) Main spillway crest (ungated): 606.0
Emergency spillway crest (ungated): 606.2
- (7) Upstream portal invert diversion tunnel:
N/A
- (8) Stream bed at centerline of dam: 594.0
- (9) Maximum tailwater: None

d. Reservoir

- (1) Length of maximum pool: 1,200 feet
- (2) Length of recreation pool: 1,200 feet
- (3) Length of flood control pool: N/A

e. Storage (acre-feet)

- (1) Test flood surcharge: 90 at 611.8
- (2) Top of dam: 150
- (3) Flood control pool: N/A
- (4) Recreation pool: 100 (Approximate)

(5) Spillway crest: 100

f. Reservoir Surface (acres)

*(1) Top dam: 15

*(2) Maximum pool: 15

(3) Flood-control pool: N/A

(4) Recreation pool: 15

(5) Spillway crest: 15

g. Dam

(1) Type: earthfill

(2) Length: 510 feet

(3) Height: 15 feet

(4) Top width: Crest varies from 7 to 15 feet

(5) Side slopes: 1:1 to 4:1

(6) Zoning: Unknown

(7) Impervious core: Unknown

(8) Cutoff: Unknown

(9) Grout curtain: Unknown

i. Spillway

(1) Type: Broad crest

(2) Length of weir: 37.7 feet

*Based on the assumption that the surface area will not significantly increase with changes in reservoir elevation from 606 to 609.5.

- (3) Crest elevation: 606 MSL (assumed benchmark)
- (4) Gates: None
- (5) Upstream Channel: None
- (6) Downstream Channel: Stone cascade to 35-foot wide stream bed
- (7) General: Emergency spillway (ungated) - crest El 606.2, bottom width 13 feet, top width 33 feet, height 5 to 8 feet, length 470 feet.

j. Regulating Outlets. The only apparent regulating outlet is a 12-inch diameter, 45-foot long cast-iron conduit. The outlet has a capacity of 8 cfs (1.1 cfs per square mile). It is controlled by a gate valve operated by a hand wheel. The downstream end of the conduit is located at the toe of the dam. According to the Owner, the outlet was last operated four years ago, and is still operable. It was not opened at the time of inspection.

SECTION 2

ENGINEERING DATA

- 2.1 General. The only plans, specifications, or computations available from the Owner, State, or County offices relative to the design, construction, or repairs of this dam are: an undated sketch of the spillway plan and sections showing no measurements or elevations, and a drawing dated 1958 showing the proposed reconstruction of the gate valve housing (copies in Appendix B). The only other data available for this evaluation were visual observations during inspection, review of previous inspection reports, and conversations with the Owner and with personnel from the State and County agencies.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works: Messrs. Willis Regan and Raymond Rochford, and of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways: Messrs. John J. Hannon and Joseph Iagallo.

Also, we acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office: Messrs. John O'Toole, Joseph Brazauskas, and Mr. Wallace Lindquist - recently retired from county service.

In addition, we thank Mr. James Thurston, President of Smith Pond, Inc., Owners of the dam, who allowed us to inspect the dam and who provided us with information on the history and operating characteristics of the dam.

- 2.2 Construction Records. There are no detailed construction records available.
- 2.3 Operation Records. No operation records are available, and there is no daily record kept of pool elevation or rainfall at the dam site.
- 2.4 Evaluation.
- a. Availability. Due to its age, there is limited engineering data available.

- b. Adequacy. The lack of indepth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.
- c. Validity. The limited data available is considered valid.

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I Inspection of the dam at Cook Pond was performed on July 10, 1978. A copy of the inspection check list is included in Appendix A. Periodic inspections of this dam by others have been made since 1925. A listing of these inspections is in Appendix B. An inspection was made in 1973 by personnel from the Massachusetts Department of Public Works. A copy of their report is included in Appendix B.
- b. Dam. Cook Pond Dam is an earthfill dam. There is no information on the zoning or core, since it was probably constructed about 150 years ago. Several signs of distress are visible, the most severe being seepage along the downstream toe 30 feet east of the spillway. The seepage forms a pool of water which flows downstream and into the main stream channel just upstream of the emergency spillway. Several other smaller seeps flow into the main stream of seepage. Some of these smaller seeps are bright orange in color.

The upstream and downstream slopes on both sides of the main spillway are steep, sloping at 1:1. Trees along the downstream face of the embankment to the east are tilted downstream which could indicate creep of the slope. In addition, footpaths have been worn adjacent to the sides of the spillway, leaving unprotected earth slopes. The crest on both sides of the spillway is eroded, forming the lowest elevations of the top of the dam. The upstream face of the embankment is not protected with riprap, and local sloughing occurs east and west of the main spillway. Outcrops of granite bedrock were noted in the left abutment area.

There is extensive tree and brush growth on both upstream and downstream slopes of the entire embankment. The footpath along the crest is worn and irregular.

- c. Appurtenant Structures. The main spillway is a 37.7-foot long reinforced concrete weir with dry-stone masonry sidewalls and a downstream stonework cascade. A reinforced concrete pier is located in about the center of the weir to support an overhead footbridge. The concrete forming the weir is in poor condition, especially downstream of the pier where erosion has exposed the reinforcing bars. The lower 1 foot of the concrete pier is also severely eroded, exposing the reinforcing, and the remaining portion of the pier is cracked. Two sections of the upstream edge of the weir are missing and eroded. The eroded areas are 3.7 feet wide along the west wall, and 7.2 feet wide along the east wall, and water is flowing over the spillway at these points. Local cracking and minor spalling occurs at other locations on the weir. Stonework is missing from the downstream edge of the west sidewall and from various steps in the cascade. Wood and trash debris is lying at the foot of the cascade and in the downstream stream bed. Trees overhang the cascade and stream bed areas.

The outlet of the outlet conduit was not visible. At the reported location of the outlet, the area was overgrown with brush and covered with soil and pieces of rock.

The unlined emergency spillway is excavated in till-like overburden. The slopes are steep, about 1:1, but do not appear to be significantly eroded. The channel contains slight to moderate brush growth, except at the downstream end where there are several large trees.

- d. Reservoir Area. The drainage area is generally sparsely populated, but areas of development occur, mainly north of Cook Pond and in the southwest corner of the drainage area. About 300 residences are in the drainage area. The area is generally heavily wooded, and slopes range from about 5 to 25 percent.
- e. Downstream Channel. The discharge from the spillway flows down a boulder and cobble stream bed with earth banks to Patch Reservoir situated about 5,000 feet downstream. The slope of the stream bed is about 1 percent.

3.2 Evaluation. The above findings indicate that the dam has several signs of distress which require attention. It is evident that the dam is not adequately maintained and that deterioration will continue unless action is taken. Recommended measures to improve these conditions are stated in Section 7.

SECTION 4

OPERATING PROCEDURES

4.1 Procedures. There are no operating procedures at Cook Pond Dam.

4.2 Maintenance of Dam. The dam is not adequately maintained, although the Owner visits the dam several times a year. It was reported that brush was cleared from the emergency spillway about three years ago. Mr. James Thurston of Smith Pond, Inc. stated that the association is planning to fill in eroded areas of the embankment and repair the concrete in the main spillway this summer.

The 1973 inspection report by the Massachusetts Department of Public Works (copy in Appendix B) stated that repairs were needed to the concrete and stonework in the main spillway and that trees and brush should be cleared from the dam embankment. There was no evidence during the inspection that these repairs had been made. Numerous past inspection reports by the Worcester County Engineer's Office stated that the steep embankment slopes should be flattened. However, portions of the embankment are presently sloping at 1:1 to 2:1.

4.3 Maintenance of Operating Facilities. The Owner stated that the outlet gate is operated periodically, although the last time was four years ago. Also the Owner said the gate is operable, although it was not opened at the time of inspection. The outlet end of the conduit is supposed to be located at the toe of the dam. However, that area is heavily overgrown with brush and trees, so the outlet was not visible.

4.4 Description of Any Warning Systems in Effect.
There are no warning systems in effect at this dam.

4.5 Evaluation. There are no adequate operational, maintenance, or warning systems in effect at Cook Pond dam. This is extremely undesirable considering the fact that it is in the "high" hazard

category. A program of operation and maintenance for this dam should be implemented as recommended in Section 7.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design Data. The Probable Maximum Flood (PMF) rate was determined to be 1,800 cfs per square mile. This calculation is based on the average drainage area slope of 6.0 percent, the pond-plus-swamp area to drainage area ratio of 6.5 percent, and the U. S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). Applying one-half the PMF to the 7.1 square miles of drainage area results in a calculated peak flood flow of 6,390 cfs as the inflow test flood. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 6,230 cfs (877 cfs per square mile), with a water surface at El 611.8.

Flow over the dam crest is predicted to be 4,442 cfs. Flow through the main spillway (assuming the footbridge had been washed away) would be 1,388 cfs and flow through the emergency spillway would be 390 cfs. The maximum head on the dam would be 2.3 feet with a discharge of 8.61 cfs per foot of width. Depth at critical flow would be at 1.3-foot with a velocity of 6.2 feet per second.

The inflow from a 100-year frequency storm was estimated to be 2,690 cfs. After adjustment for surcharge storage, the outflow from the 100-year storm was calculated to be 2,566 cfs which would result in a water surface at El 610.6 or about 0.9 feet over the dam crest.

Hydraulic analyses indicate that the existing main spillway and emergency spillway can discharge flows of 693 cfs and 144 cfs at water surface El 609.5 which is the approximate average dam crest. The combined discharge of 837 cfs is equivalent to 13 percent of the test flood outflow.

- b. Experience Data. Hydraulic records are not generally available for this dam. However, past inspection reports indicate that the dam was overtopped in 1938. The maximum pond level during the flood was El 610.2. It was reported that the emergency spillway was constructed in 1939 after the 1938 floods. Since that time there are no records of dam overtopping, although the emergency spillway has been frequently used.
- c. Visual Observations. Discharge from Cook Pond is through the main spillway and the emergency spillway located east of the left abutment (see Figure B-1). Since the emergency spillway is only 0.2 feet above the crest of the main spillway, the emergency spillway would be expected to discharge flow on a regular basis and not just during severe storm flows. This has been corroborated by verbal information supplied by the Owner.

The visual inspection on July 10, 1978 showed that brush and trees had been recently cleared from the emergency spillway. This indicates that some maintenance has been done to insure unrestricted flow through the emergency spillway.

The concrete weir at the main spillway shows signs of severe erosion. The erosion downstream of the footbridge pier was probably caused by cavitation during supercritical flow due to the poor hydraulic design of the pier.

- d. Overtopping Potential. Overtopping of the dam is expected under the test flood of 6,390 cfs (inflow) as well as the 100-year frequency flood; as noted previously, however, the only available records on overtopping indicate that the dam has not been overtopped since 1938, when the outflow was approximately 940 cfs. The emergency spillway was constructed in 1939. In the event of overtopping, complete failure of the dam could occur. A flood wave resulting from dam failure could cause appreciable property damage and numerous loss of life.

Failure of the dam would produce a peak discharge of 4,210 cfs, as estimated using Corps of Engineers criteria, with a flood wave in the order of 9 feet. The volume from Cook Pond would raise the level of Patch Reservoir by 6 feet.

- e. Additional Hydraulic Considerations. As shown in Figures D-1 and D-2 in Appendix D, Cook Pond is located downstream of Holden Reservoirs No. 1 and No. 2. However, the hydrologic and hydraulic calculations for this Phase I Investigation have been based on U. S. Army Corps of Engineers guide curves which do not fully consider the storage-discharge characteristics of upstream reservoirs. Therefore, the conclusions on peak flood flows and dam overtopping should be considered as preliminary only. A more detailed hydraulic and hydrologic investigation should be based on the storage effects of upstream reservoirs.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of Cook Pond Dam is mainly based on the visual inspection conducted on July 10, 1978. Based on the observations as discussed in Section 3, Visual Inspection, Cook Pond Dam is considered a hazard. Conditions at the dam are unsatisfactory and conventional factors of safety may not exist.

It is recommended that a more detailed investigation be initiated to evaluate the dam stability and seepage at the downstream toe of the dam.

- b. Design and Construction Data. Discussions with the Owner, County, and State personnel indicate that there are no detailed plans, specifications, or computations relative to the design or construction of this dam. Furthermore, information on the type, shear strength, and permeability of the soil and/or rock materials of the dam embankment does not appear to exist.

Cook Pond Dam was probably built about 1830, presumably of local soil or rock materials. There is no data, however, on the type of the impervious core wall.

- c. Operating Records. There is no evidence of instrumentation of any type in Cook Pond Dam, and there is nothing to indicate that any instrumentation was ever installed in this dam. The performance of this dam under prior loading can only be inferred by physical evidence at the site.

- d. Post-Construction Changes. There are no as-built drawings for Cook Pond Dam. The Owner indicates that the embankment was repaired and the section west of the main spillway was partially refilled and widened about 1939. The emergency spillway was also excavated at about the same time. In 1958, the original wooden gate house for the outlet conduit burned down, and the present metal corrugated housing was installed. In 1974, trees and brush were cleared from the emergency spillway channel.
- e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analyses.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. Due to its age, Cook Pond Dam was neither designed nor constructed according to current approved state-of-art procedures. Based upon the visual inspection at the site, the lack of engineering data available, and limited operational or maintenance information, there are areas of concern which must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in fair to poor condition. There were several signs of distress observed at the site: seepage at the downstream toe of the dam, buried outlet of the outlet conduit, steep embankment slopes near the spillway, severe erosion of the spillway weir and pier, heavy growth of trees and brush on the dam embankment and downstream areas, erosion and lack of riprap on the upstream face of the dam, stonework missing from the west spillway sidewall and cascade, and wood/trash debris in the downstream stream bed.

Hydraulic analyses indicate that the main spillway can discharge a flow of 693 cfs and the emergency spillway a flow of 144 cfs at El 609.5 which is the approximate average dam crest. The lowest point on the dam crest is El 608.6 which is a localized area of erosion near the spillway. An inflow test flood of 6,390 cfs (one-half the probable maximum flood) will overtop the main dam by about 2.3 feet. The combined spillways will discharge only 13 percent of the adjusted test flood outflow (877 cfs per square mile) before the dam is overtopped. The inflow from a 100-year-frequency storm would result in a water surface at El 610.6 or about 0.9 feet above the crest of the dam. Previous records at this site indicate the dam was not overtopped in the 1955 floods due to the regulating effects of upstream

reservoirs. However, future development in the watershed could increase the runoff and alter conditions.

- b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.
- c. Urgency. The recommendations outlined below should be implemented within 1 year after receipt of the Phase I Inspection Report.
- d. Need for Additional Information. Additional investigations to further assess the adequacy of the dam and appurtenant structures are outlined below in Section 7.2 Recommendations.

7.2 Recommendations. In view of the concerns over the continued performance of this dam, it is recommended that the Owner employ a qualified consultant to:

- a. evaluate the stability of the dam
- b. evaluate the seepage at the toe of the dam
- c. conduct a more detailed hydrologic and hydraulic investigation for the entire drainage area. The purpose of the investigation is to design a means of increasing the discharge capabilities at the dam and to evaluate the outlet capacity.

The recommendations on repairs and maintenance procedures are stated below under Section 7.3 Remedial Measures.

7.3 Remedial Measures

- a. Alternatives. An alternative to the recommendations above and maintenance procedures itemized below would be draining the reservoir and breaching or removing the dam.

b. Operation and Maintenance Procedures. The dam and appurtenant structures are not adequately maintained. It is recommended that the Owner accomplish the following items:

- (1) remove the blockage at the outlet pipe
- (2) repair the concrete on the spillway weir and pier
- (3) cut down trees and clear brush from the embankment to 20 feet downstream of the toe, from the sides of the downstream stream channel, and from the emergency spillway channel
- (4) repair eroded areas of the upstream face of the dam face and protect with riprap or other suitable material
- (5) replace missing stonework from west wall of spillway and cascade
- (6) clear wood and trash debris from stream bed below spillway cascade
- (7) provide around the clock surveillance during periods of unusually heavy precipitation. The Owner should develop a formal warning system with local officials for alerting downstream residents in case of emergency.
- (8) implement a systematic program of inspection and maintenance. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances, supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in accordance with all applicable State regulations.

APPENDIX A
PERIODIC INSPECTION CHECKLIST

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Cook Pond

DATE 7/10/78

TIME 9:00 AM

WEATHER Sunny - 85°F

W.S. ELEV. 595.4 * U.S. 543 DN.S.

* assumed bottom is 606 top of raised lip, west end spillway crest

PARTY:

1. Ed Greco

6. David Cole

2. Lyle Branagan

7. Frank Sviokla

3. Richard Kleber

8. _____

4. Carol Sweet

9. _____

5. Susan Pierce

10. _____

PROJECT FEATURE

INSPECTED BY

REMARKS

1. dam embankment

Ed Greco

2. spillway/emergency spillway

Lyle Branagan

3. intake of outlet conduit

Ed Greco

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

PERIODIC INSPECTION CHECK LIST

PROJECT Cook Pond Dam DATE July 10, 1978
 PROJECT FEATURE dam embankment NAME Ed Greco
 DISCIPLINE geotechnical NAME Richard Weber

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	608.6 to 609.7
Current Pool Elevation	605.9
Maximum Impoundment to Date	unknown
Surface Cracks	none visible
Pavement Condition	none - crest is earth footpath
Movement or Settlement of Crest	crest irregular
Lateral Movement	steep DS slope at left abutment
Vertical Alignment	crest elevation varies
Horizontal Alignment	irregular
Condition at Abutment and at Concrete Structures	fill in right abutment, ledge at left abutment, steep slopes at spillway abutments
Indications of Movement of Structural Items on Slopes	numerous trees growing on dam - sloping trunks on slopes near spillway
Trespassing on Slopes	path on ds face left abutment of spillway - chipmunk holes
Sloughing or Erosion of Slopes or Abutments	erosion left + right of spillway
Rock Slope Protection - Riprap Failures	none - scattered stones
Unusual Movement or Cracking at or near Toes	none visible
Unusual Embankment or Downstream Seepage	slight seep at ds toe 30ft. left of spillway - smaller seeps ds along outlet channel
Piping or Boils	none visible
Foundation Drainage Features	none visible
Toe Drains	none visible
Instrumentation System	none visible

PERIODIC INSPECTION CHECK LIST

PROJECT Cook Pond Dam
 PROJECT FEATURE main spillway
 DISCIPLINE geotechnical

DATE July 10, 1978
 NAME Lyle Brannigan
 NAME Ed Greco

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR,*</u> <u>APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	None
General Condition	NA
Loose Rock Overhanging Channel	NA
Trees Overhanging Channel	NA
Floor of Approach Channel	NA
b. Weir and Training Walls	weir slab- reinforced concrete training walls- mortared masonry
General Condition of Concrete	poor
Rust or Staining	reinforcing mesh exposed on conc. pier + weir
Spalling	along right + left sides of weir
Any Visible Reinforcing	at base of pier + ds on weir
Any Seepage or Efflorescence	none visible
Drain Holes	none
c. Discharge Channel	stone cascade steps
General Condition	poor to fair - some dislodged stones
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	right abutment
Floor of Channel	small stone - debris - logs
Other Obstructions	none

* emergency spillway 390' east from spillway

a) earthen channel - trapezoidal - 15ft wide at bottom, side slopes 1.5:1 ±

b) small brush - recently cleared

c) 400ft long - connects to discharge channel 100' ds of dam

PERIODIC INSPECTION CHECK LIST

PROJECT Cook Pond Dam DATE July 10, 1978
 PROJECT FEATURE intake of outlet conduit NAME Ed Greco
 DISCIPLINE geotechnical NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
a. Approach Channel	<i>None</i>
Slope Conditions	<i>NA</i>
Bottom Conditions	<i>NA</i>
Rock Slides or Falls	<i>NA</i>
Log Boom	<i>NA</i>
Debris	<i>NA</i>
Condition of Concrete Lining	<i>NA</i>
Drains or Weep Holes	<i>NA</i>
b. * Intake Structure	<i>4' diameter x 7' high - corrugated metal</i>
Condition of Concrete	<i>None</i>
Stop Logs and Slots	<i>None visible</i>

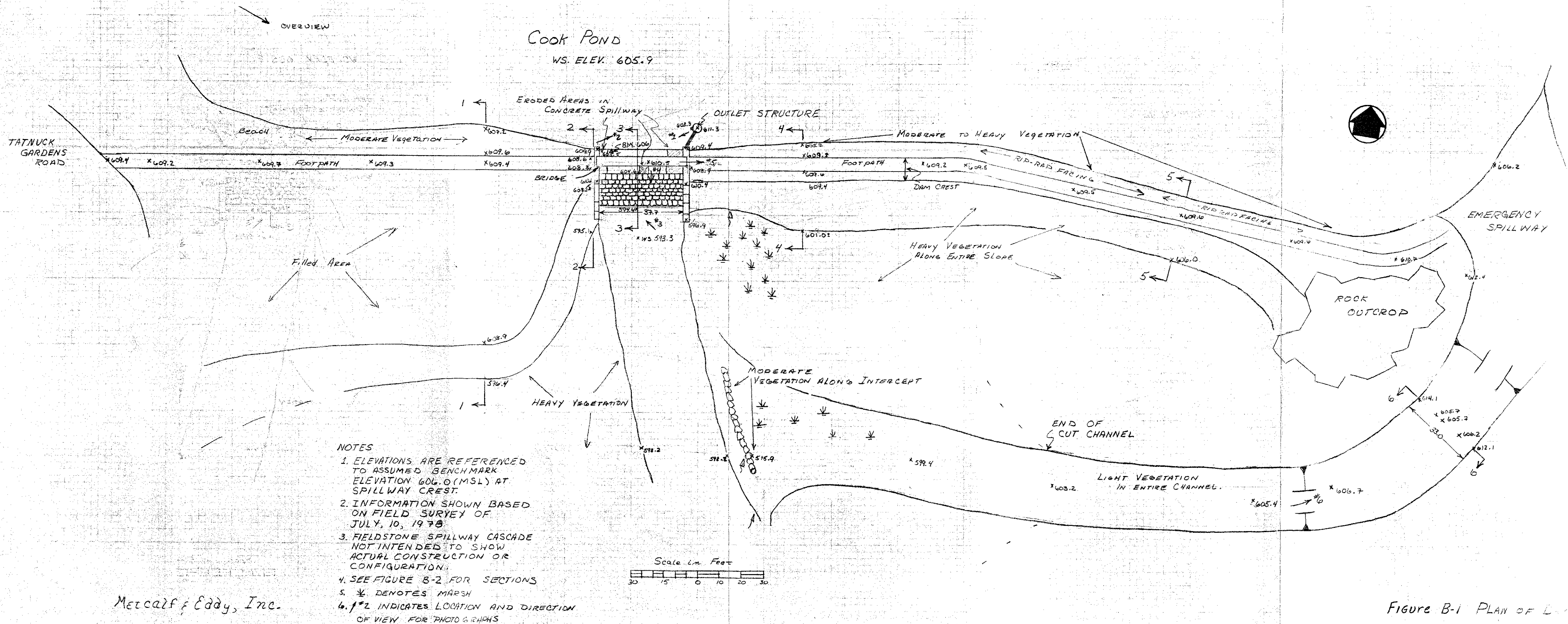
* apparent outlet control:

6 ft. walkway from left us corner of spillway training wall
 2 ft. wide steel plate - 1/4" on steel channel
 steel plate to corrugated metal pipe - locked
 no outlet conduit visible - us or ds
 outlet of pipe - unknown

APPENDIX B

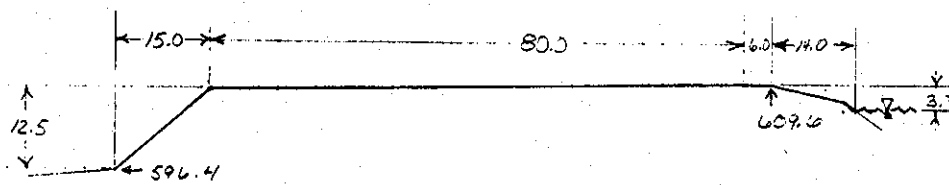
PLAN OF DAM, AND PREVIOUS INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam	B-1
Figure B-2, Sections	B-2
Figure B-3, Sketch of Spillway, undated	in pocket
Figure B-4, Drawing of Gate House Improvements, dated 1958	in pocket
Previous Inspections (Partial Listing)	B-5
Inspection Report by Massachusetts Department of Public Works January, 1973	B-6

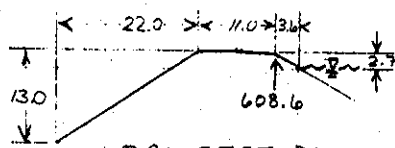


Metcalf & Eddy, Inc.

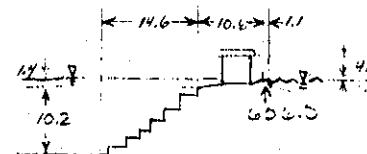
Figure B-1 PLAN OF D...



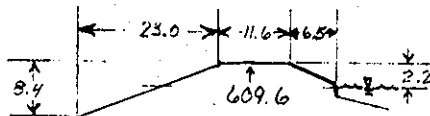
DAM SECTION 1-1
WS. ELEV. 605.9



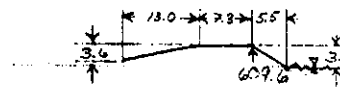
DAM SECTION 2-2



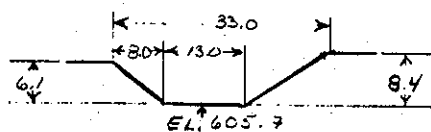
SPILLWAY SECTION 3-3



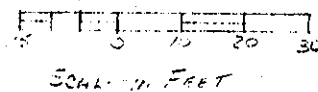
DAM SECTION 4-4



DAM SECTION 5-5



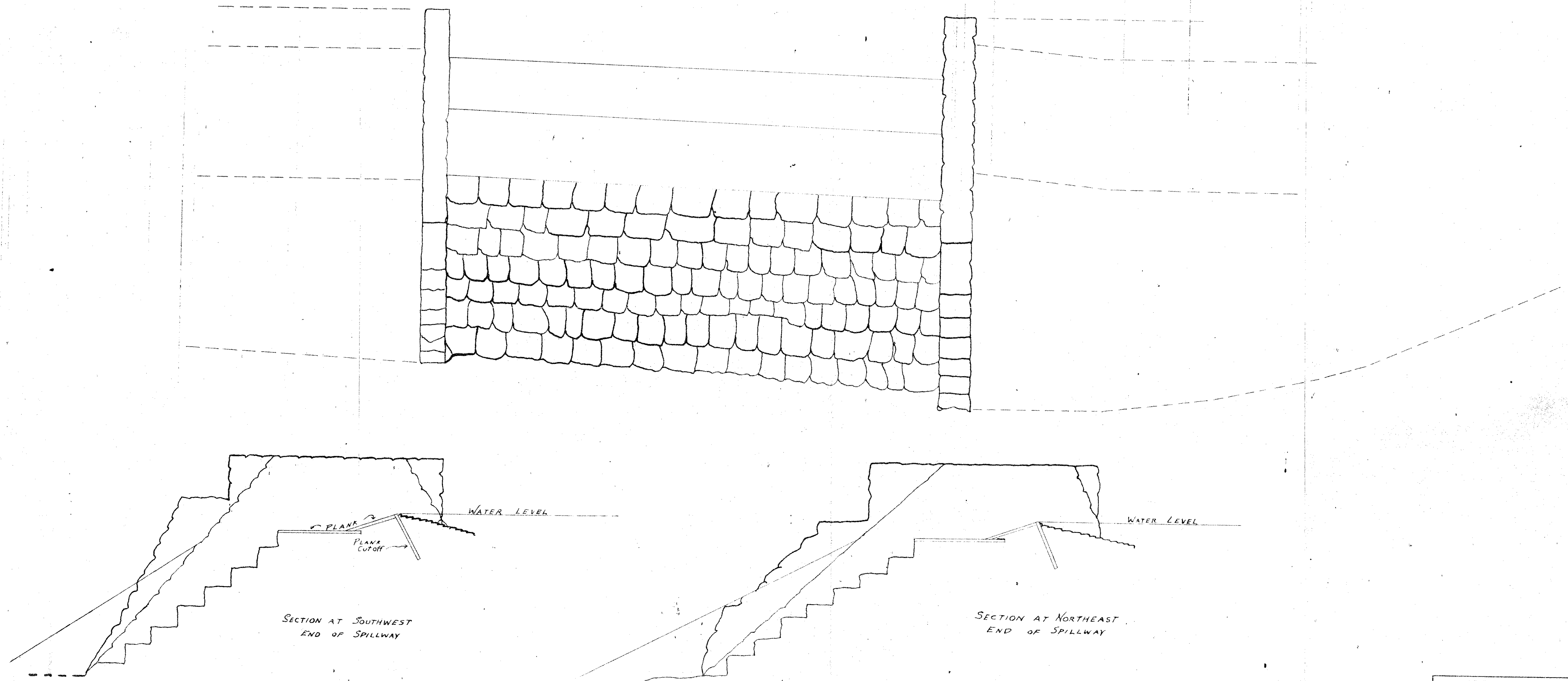
EMERGENCY SPILLWAY SECTION 6-6



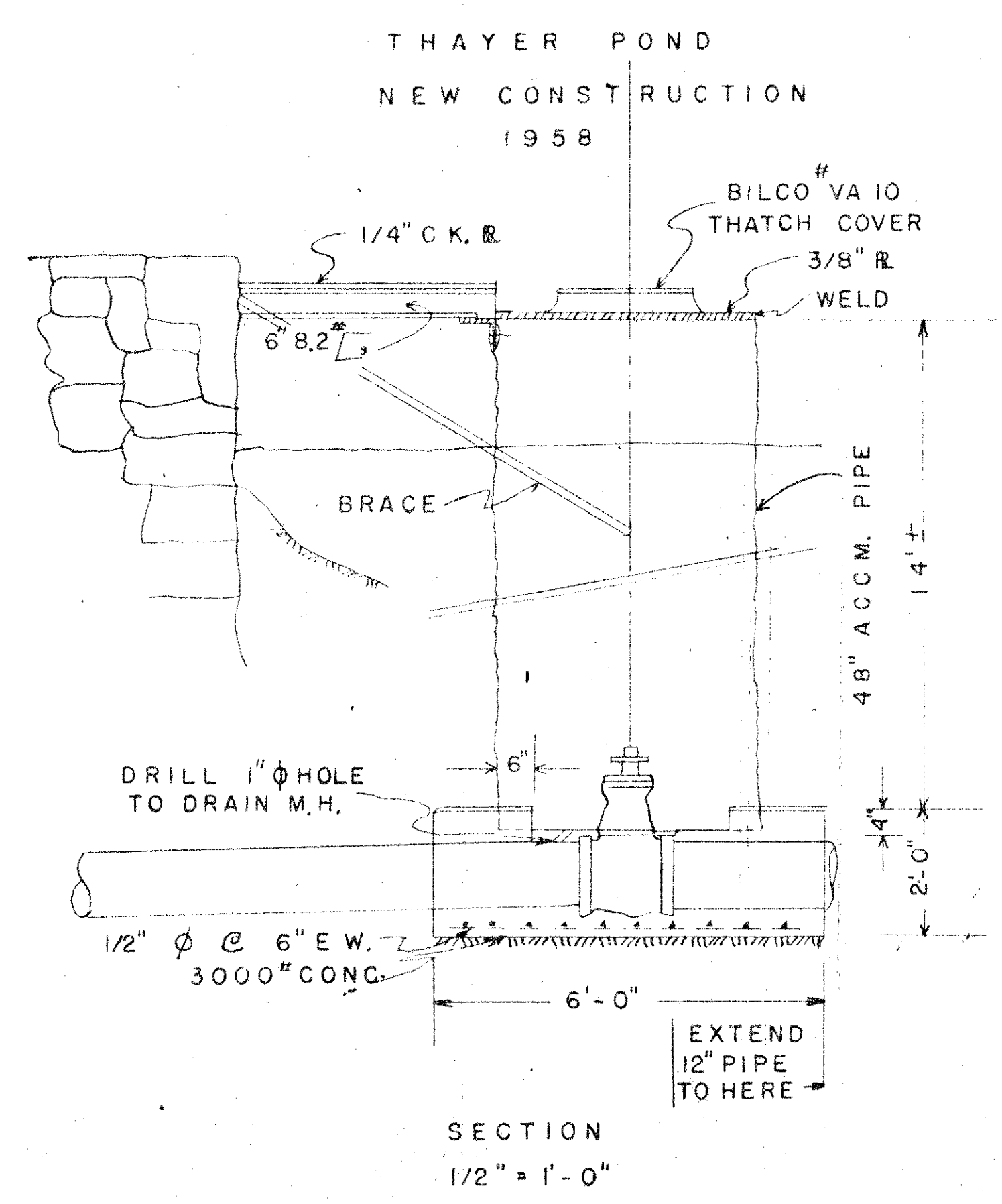
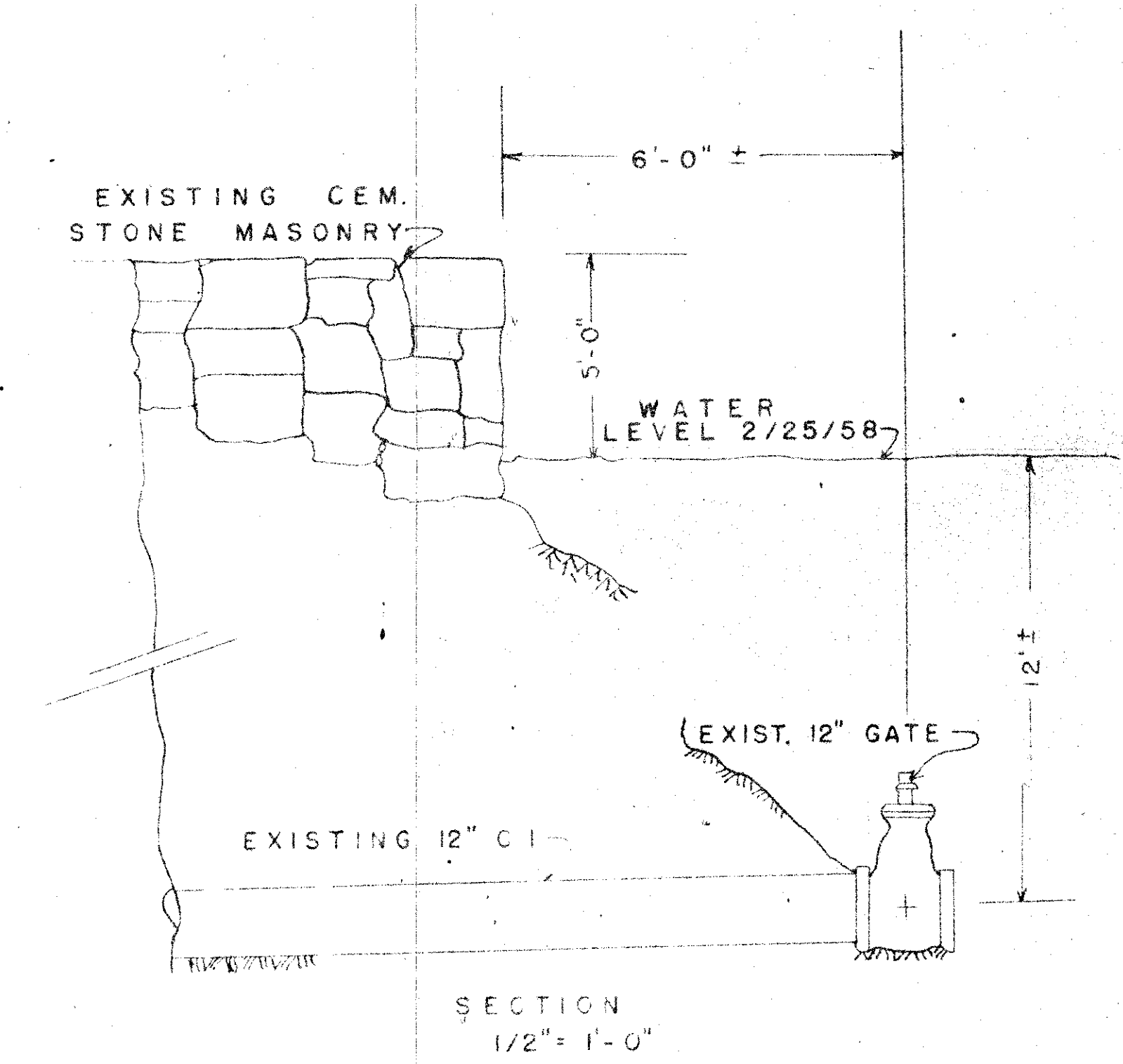
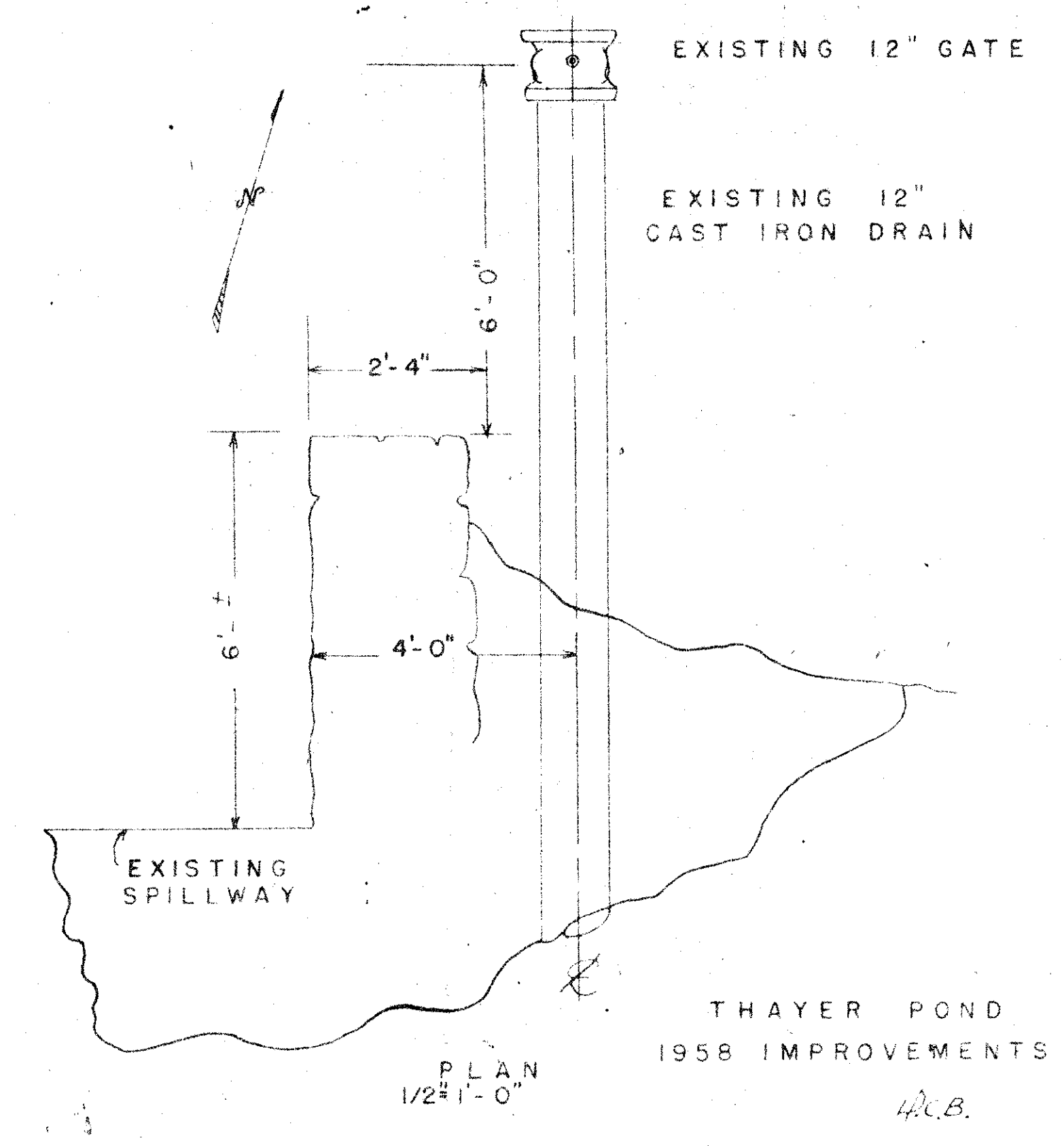
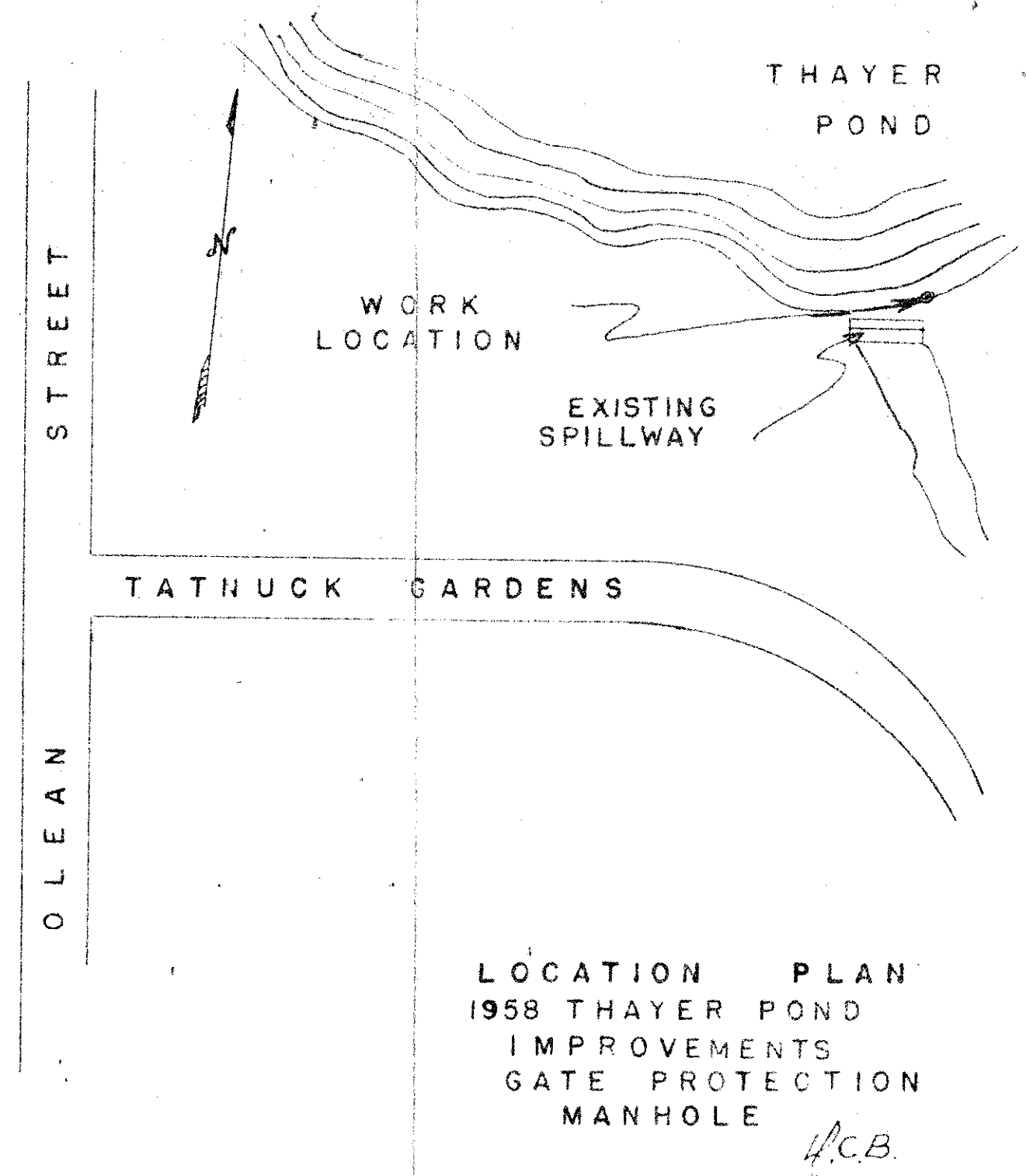
SCALE IN FEET

Metcalfe & Eddy, Inc.

Figure B-2 DAM SECTIONS



WORCESTER COUNTY COMMISSIONERS WORCESTER COUNTY ENGINEERING DEPARTMENT PLAN OF DAM COOKS POND SPILLWAY WORCESTER AS FILED AND APPROVED BY THE COUNTY COMMISSIONERS	
SCALES AS NOTED	
TRACED BY: <i>AG Callahan 3-8-61</i> TRACING CHECKED BY:	DAM NO. 61-13
_____ COUNTY ENGINEER	



R.H. WHITE CONSTRUCTION COMPANY, INC.
41 CENTRAL ST.
AUBURN, MASS.

WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT

PLAN OF
GATE IMPROVEMENTS
THAYER POND
WORCESTER, MASS.
COUNTY COMMISSIONERS

SCALES AS NOTED

TRACED BY: *E.J. Callahan 2-12-58*
TRACING CHECKED BY: *W.D. 2-17-58*

DAM NO. 61-13

COUNTY ENGINEER

TOWN OR CITY *Worcester*

DECREE NO.

PLAN NO.

*1936
Flood*

DAM NO.

*61-13*LOCATION *near West Tatnuck**- Cooks Pond*

C. C. DOCKET NO.

DESCRIPTION OF DAM

El. 100'

Type *Earth-masonry-abts. stepped stone*
 Length *470.1*
 Height *14' 11"*
 Thickness top *7' 11"*
 " bottom *spill: 40' t*
 Downstream Slope *1:1 Earth*
 Upstream " *1/2:1 riprap*
 Length of Spillway *38.4*
 Size of Gates *12" iron pipe*
 Location of Gates *just to North of spillway*
 Flashboards used
 Width Flashboards or Gates
 Dam designed by
 " constructed by
 Year constructed

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream *Tatnuck Brook*
 " " any other Streams
 Length of Watershed
 Width " "
 Is Watershed Cultivated
 Percent in Forests
 Steepness of Slope *Needs spillway 60'0" x 2'9" deep*
 Kind of Soil *1 1/2:1 slopes - on spillway*
 No. of Acres in Watershed *7.33 6 M.*
 " " " " Reservoir
 Length of Reservoir
 Width " "
 Max Flow Cu. Ft. per Sec.
 Head or Flashboards-Low Water
 " High "

GENERAL REMARKS

1957 - Smith & Brown, Inc.
 Owner *Tatnuck Club*
 Date inspected - *Sept. 10, 1925 LOM*
F.R. Smith, Estl
 Inspected: *May 7, 1927 - L.O. Marden*
 " *Sept. 14, 1932 by L.O. Marden*
 " *Mar. 19, 1936 L.C. Farrar*
 " *Mar. 14, 1936 L.C. Farrar, H.D. Vasselin*
 " *Oct. 19, 1936 L.O.M.*
 " *Nov. 17, 1938 L.H. Spofford*
 " *JUNE 16, 1948 - LOM*

GENERAL REMARKS

Patrol: March 1, 1939 - B.P. St John.
Measured spillway - Oct. 5, 1938 - B.P. St. J. E.S. Grover
 " " " *10, 1932 - Finlayson-Hunt-Vasselin*
Field Book 46 Page 135.
Inspected: Dec 9, 1940 - L.H.S.
 " *Dec. 7, 1942 LOM-J.F.C.*
 " *Dec. 11, 1945 - W.O. Lindquist*
 " *June 30, 1950 - LOM.*
1936 Flood 10 El. 610.2

2-Library Version 10-92260

PREVIOUS INSPECTIONS (PARTIAL LISTING)

COPY OF INSPECTION CARD ON FILE AT THE MASSACHUSETTS
 DEPARTMENT OF PUBLIC WORKS, DISTRICT OFFICE, WORCESTER.

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: City/Town WORCESTER Dam No. 314-348-13

Name of Dam COOK POND DAM Inspected by MULCAHY DONAHUE

Date of Inspection 1/11/73

2. Owner/s: per: Assessors _____ Prev. Inspection /

Reg. of Deeds _____ Pers. Contact _____

1. SMITH POND INC. % PHILIP M THURSTON, 43 TORY FORT LANE, WORC.
Name _____ St. & No. _____ City/Town _____ State _____ Tel. No. _____

2. _____
Name _____ St. & No. _____ City/Town _____ State _____ Tel. No. _____

3. _____
Name _____ St. & No. _____ City/Town _____ State _____ Tel. No. _____

3. Caretaker (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Name: _____ St. & No.: _____

City/Town: _____ State: _____ Tel.No.: _____

4. No. of Pictures taken NONE

5. Degree of Hazard: (if dam should fail completely)*

1. Minor _____ 2. Moderate /

3. Severe _____ 4. Disastrous _____

* This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual /

Operative _____ yes; _____ No.

Comments: _____

7. Upstream Face of Dam: Condition:

1. Good / 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments: _____

DAM NO. 3-14-247-13

8. Downstream Face of Dam:

Condition: 1. Good _____ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

9. Emergency Spillway: NONE

Condition: 1. Good _____ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

10. Water Level at time of inspection: 4.4 ft. above _____ below ✓
top of dam ✓ principal spillway _____
other _____

11. Summary of Deficiencies Noted:

—Growth (Trees and Brush) on Embankment YES
—Animal Burrows and Washouts NONE
—Damage to slopes or top of dam NONE
—Cracked or Damaged Masonry RETAINING WALL IN RIGHT HAND CORNER
Evidence of Seepage NONE
Evidence of Piping NONE
Erosion CENTER PIER OF DAM + PART OF THE RIGHT HAND CORNER OF SPILLWAY
Leaks NONE
Trash and/or debris impeding flow NONE
Clogged or blocked spillway NO
Other _____

12. Remarks & Recommendations: (Fully Explain)

THE CEMENT CONCRETE SPILLWAY SHOWS SIGNS OF EROSION IN THE RIGHT HAND CORNER OF THE SPILLWAY. THIS CONDITION WILL CONTINUE TO EXIST UNTIL REPAIRS ARE MADE TO THE SPILLWAY AND TO THE FIELDSTONE RETAINING WALL WHERE SOME SEEPAGE IS TAKING PLACE AND WATER COMING ONTO THE SPILLWAY IN THIS AREA IS CAUSING THE EROSION. THERE IS ALSO EROSION TAKING PLACE AROUND THE CONCRETE-CENTER PIER THE PURPOSE OF THIS PIER IS TO SUPPORT PEDESTRIAN WALK. SOME OF THE FIELDSTONE IN THE STEPPING AT THE SPILLWAY HAVE FALLEN OUT OF PLACE AND SOME MINOR REPAIRS TO CORRECT THIS CONDITION SHOULD BE MADE. THE FIELDSTONE RETAINING WALLS ALSO NEED MINOR REPAIRS GROWTH OF BRUSH AND TREES ON EARTH EMBANKMENT SECTION OF DAM SHOULD BE REMOVED TO ELIMINATE ANY HAZZARD THEY MIGHT POSE TO THE DAM

13. Overall Condition:

1. Safe ✓
2. Minor repairs needed ✓
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

DESCRIPTION OF DAM

DISTRICT 3

Submitted by MURPHY - DORRIS Dam No. 3-14-348-13

Date 1/11/73 City/Town WORCESTER

Name of Dam COOK POND DAM

1. Location: Topo Sheet No. 20 D

Provide 8 1/2" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: _____ Year/s of subsequent repairs _____

3. Purpose of Dam: Water Supply _____ Recreational ☒ _____
Irrigation _____ Other _____

4. Drainage Area: 7.33 sq. mi. _____ acres

5. Normal Ponding Area: 13 ± acres; Ave. depth _____

Impoundment: _____ gals.; _____ acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir
10 WOOD FRAME i.e. summer homes, etc. _____

7. Dimensions of Dam: Length 520' Max. Height 15'

Slopes: Upstream Face 1 1/2:1

Downstream Face 1 1/2:1

Width across top VARIES 12-15'

8. Classification of Dam by Material:

Earth ☒ Conc. Masonry ☒ Stone Masonry ☒

Timber _____ Rockfill _____ Other _____

9. A. Description of present land usage downstream of dam:

_____ % rural; 100 % urban.

B. Is there a storage area or flood plain downstream of dam which could accomodate the impoundment in the event of a complete dam failure? yes ☒ no _____

DAM NO. 3-14-348-13

10. Risk to life and property in event of complete failure.

No. of people 40.

No. of homes 8.

No. of Businesses NONE.

No. of industries NONE. Type _____

No. of utilities NONE. Type _____

Railroads NONE.

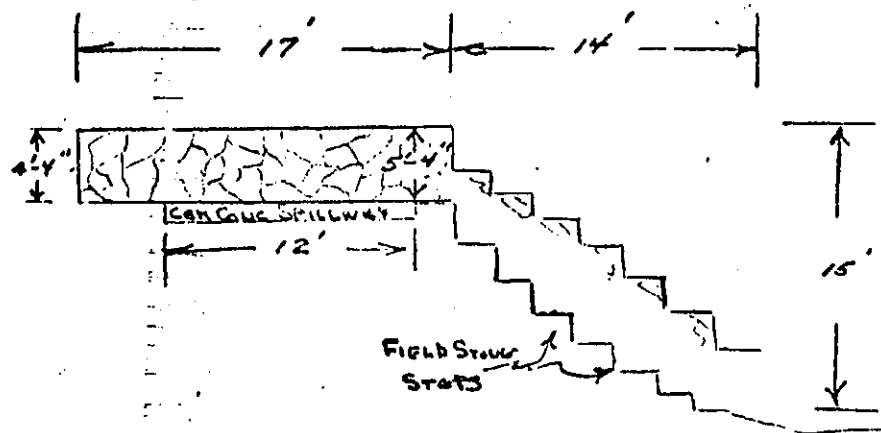
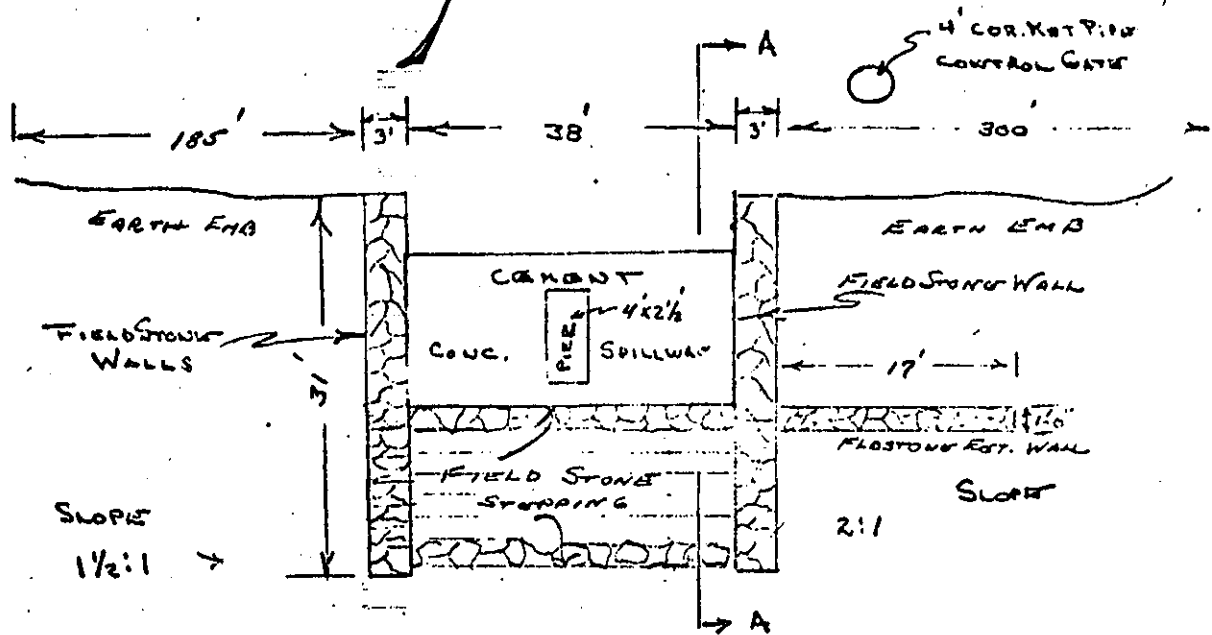
Other dams SMITH MILL POND

Other _____.

11. Attach Sketch of dam to this form showing section and plan on 8½" x 11" sheet.

12. HOW TO LOCATE: FROM INTERSECTION OF CHANDLER AND PLEASANT STS. GO UP POWER ST. (OPPOSITE CHANDLER) STRAIGHT UP CLEAV ST. 0.2 MI. TO TATNACK GARDENS TAKE RT. DAM OPPOSITE HOUSE #11.

WORCESTER
COOK POND DAM
JAN 16 3-14-348-13



SECT A-A

APPENDIX C
PHOTOGRAPHS



NO. 1 SPILLWAY WEIR



NO. 2 GATE HOUSE FOR OUTLET CONDUIT



NO. 3 WEST ABUTMENT OF SPILLWAY, DOWNSTREAM SLOPE



NO. 4 CHANNEL DOWNSTREAM OF SPILLWAY



NO. 5 DAM CREST EAST OF SPILLWAY



NO. 6 EMERGENCY SPILLWAY, VIEW LOOKING UPSTREAM

APPENDIX D
HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

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Figure D-1 - Watershed Plan	In pocket
Figure D-2 - Map of Drainage Area	D-10

(I) Broad Crested Spillway - $Q_s = CLH^{1.5}$ [Ref. pp. 360-362]

$$C = 3.27 + 0.4 \frac{H}{h} ; L = L' - 0.1 NH$$

H = Physical Water Head on CREST (h_v not included)

h = Weir Height, L' = Measured Crest Length

Assumptions

For Floods or Peak Flows, $\frac{H}{h} \approx 0.5 \therefore C = 3.47$

$$L = 90\% L' ; L = 37.7' \therefore L' = 33.73$$

$$\therefore Q_s = 3.12 L' H^{3/2}$$

$$\& Q_s = 105.9 (H)^{3/2} \text{ w/ } H \text{ meas. above el. 606}$$



(II) Flow over Crest of Dam - $q_c = 3.475 \left[\frac{y}{y+h'} \right]^{1/2} (H')^{3/2}$ [Ref pp 52-3]

q_c = Disch. / ft. of width

H' & h' as defined above; $y = h' + H'$

Assumptions

For Floods (flow over dam crest)

$$H' = \frac{1}{6} h' \text{ [note } h' \approx h + H \text{ in Item (I) above]}$$

$$\therefore y = \frac{7}{6} h' \& \left[\frac{y}{y+h'} \right]^{1/2} = \left[\frac{7/6 h'}{13/6 h'} \right]^{1/2} = 0.734$$

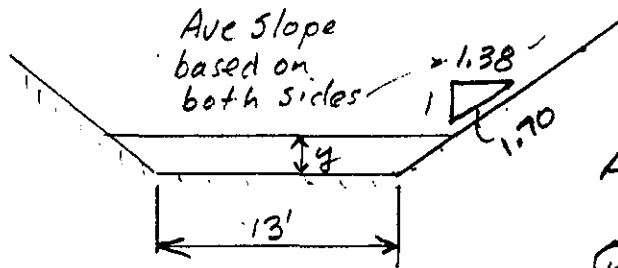
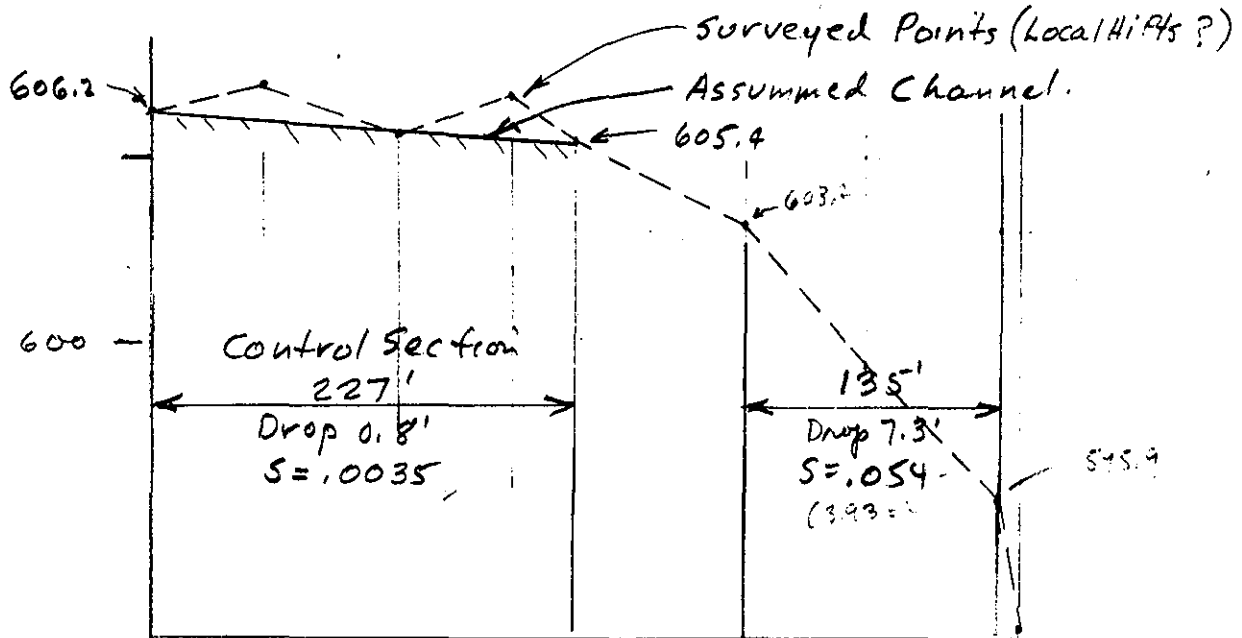
$$\therefore \boxed{q_c = 2.55 (H')^{3/2}}$$

Apply to Crest in steps where levels are roughly const.

Dam crest roughly const @ elev. 609.5 & 516' long

$$\therefore Q_c = 1316 (H')^{3/2} \text{ with } H' \text{ measured above elev 609.5}$$

III DISCHARGE OF EMERGENCY SPILLWAY



Nominal Channel Section

Control Section

$$S = .0035; n = 0.06$$

$$A = y(13 + 1.38y); P = 13 + 3.41y$$

$$Q_{ES} = A \frac{1.49}{n} R^{2/3} S^{1/2} = 1.47 A R^{2/3}$$

Loss @ Ent. = one vel. head

y	A	P	$R^{2/3}$	Q_{ES}	V	h_v	Pond Elev.
1	14.4	16.4	.917	19	1.35	0.03	607.2
2	31.52	19.82	1.362	63	2.00	0.06	608.3
3	51.42	23.23	1.698	128	2.497	0.10	609.3
4	74.08	26.64	1.977	215	2.907	0.13	610.3
5	99.5	30.05	2.222	325	3.266	0.17	611.4
0.8	11.29	15.73	0.801	13.3	1.178	0.02	607.0
3.2	55.73	23.91	1.758	144	2.584	0.10	609.5
6	127.68	33.46	2.442	458	3.59	0.20	612.4

(VI) DISCHARGE, STORAGE & ADJUSTMENT SUMMARY

Pond Elev.	Q_s	Q_{ES}	Q_C	Q_{TOT}	Storage Above Spill		For $Q_F =$	$Q_{F100} =$
					in.-mi ²	in. on D.A. (S)	6390-672.6(S)	2690-572 S ₁₀₀
606.0	—	—	—	0	0	0		
607.0	106	13	—	119	0.29	0.04	6363	
607.2	139	19	—	158	0.35	0.05	6354	
608.3	369	63	—	432	0.66	0.09		
609.3	635	128	—	763	0.95	0.13		
609.5	693	144	—	837	1.01	0.14	6296	
610.3	944	215	942	2101	1.24	0.17	6275	2593
611.4	1329	325	3447	5101	1.56	0.22	6242	2564
612.4	1715	458	6499	8672	1.84	0.26	6215	

From Discharge Curves Outflow for Test Flood = 6230 cfs.

(VII) 100 YEAR STORM

100 yr. 6 hour storm equals 4.7 inches

MIN INFILTRATION FOR B+C SOILS = $(0.18"/hr)(6.0 \text{ hours}) = 1.1 \text{ inches}$

$$Q_{100} = 12780 \left(\frac{4.7 - 1.1}{19 - 1.1} \right) = 2690 \text{ cfs. (inflow)}$$

$Q_{F100} = 2690 - 572 S_{F100}$; From Disch. Curves Outflow = 2560 cfs for 100 yr storm

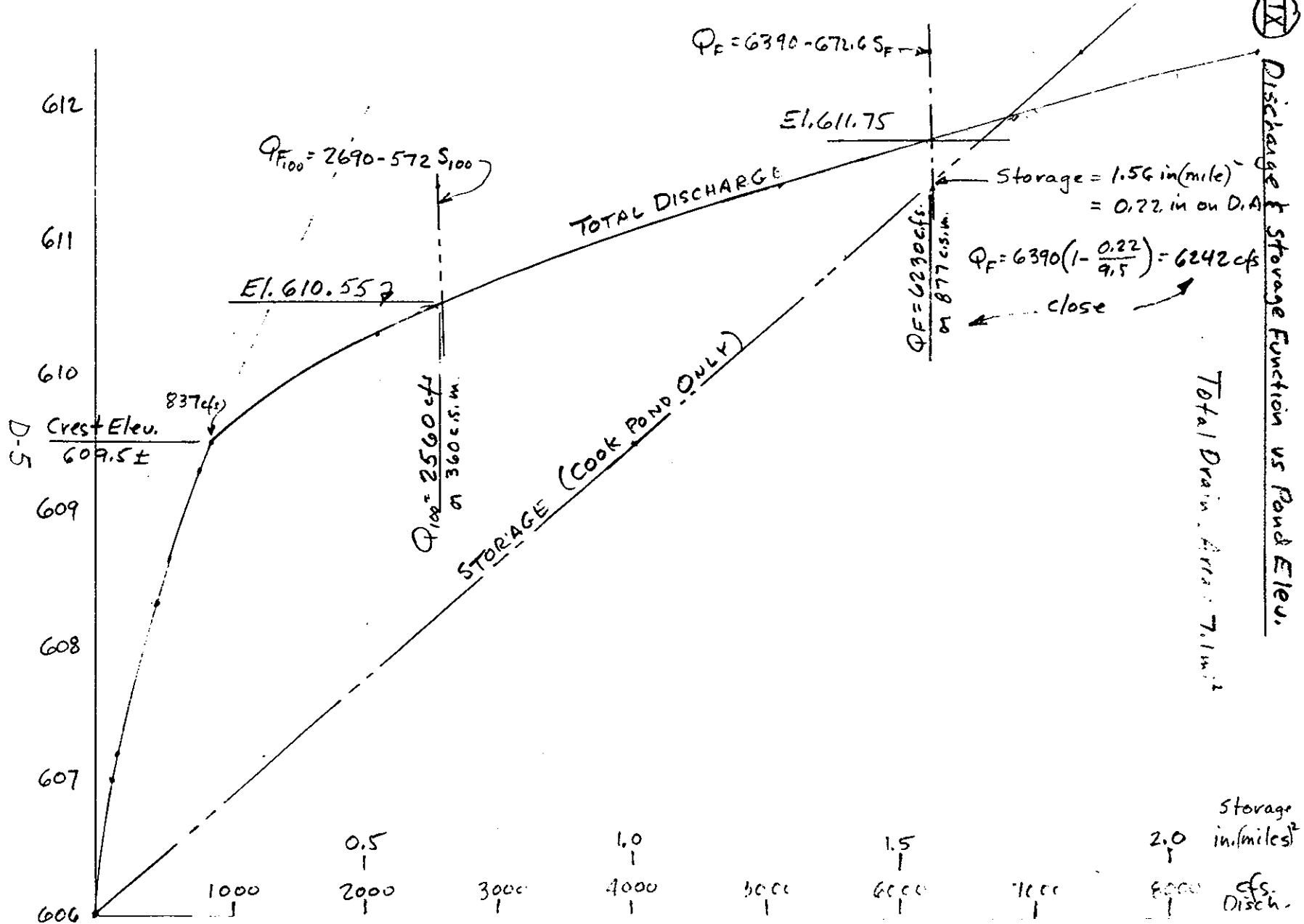
(VIII) Flow over Dam Crest

Pond Elev. 611.75, $Q_C = 1316(2.25)^{3/2} = 4441.5 \text{ cfs}$
 Ave Over Crest = 8.61 cfs/ft.

$$y_c = 1.32', V_c = 6.2 \text{ fps.}$$

Low Level Outlet [Ref. Chow "Open Chan. Hydr" - pg 498, Fig 17-30]

Outlet consists of one- 12" ϕ pipe line, assumed invert elev. 598
 Nom. Pond Elev. 606; $H = 7'$, $H/d = 7$; $Q = 8 \text{ cfs. on 1.1 c.s.m.}$



(X) Failure of Dam

Peak Failure Flow:

Pond Elevation - 611.75

Toe Elevation - 598.70

$$Y_0 = 13.05$$

Dam Length Subject to Breaching = 157' *

*157' = Mid Ht. Length of
Easterly Sect. of Dike

$$W_0 = 40\% (157) = 63$$

$$Q_R = 1.68 W_0 (Y_0)^{1.5} = 1.68 (63) (13.05)^{1.5} = \underline{4990 \text{ cfs}}$$

Storage Volume Released:

Storage Above Spillway : $0.024 (640) (5.75) = 88 \text{ Ac. ft}$

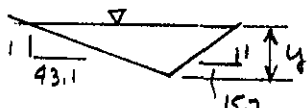
Storage Below Spillway

$$= 105 \text{ " "}$$

S = Total Storage =

$$\underline{193 \text{ " "}}$$

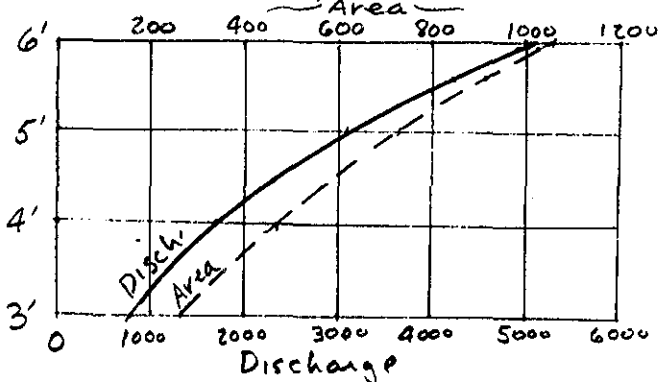
Channel Hydraulics:



$$S = \frac{10}{1190} = .0084, n \approx .06, A = \frac{1}{2} (58.8) 4^2 = 29.4 y^2$$

$$P \approx \text{Width} = 58.8 y; R = \frac{y}{2}; Q = AR^{2/3} = 2.28 AR^{4/3}$$

y	A	R ^{2/3}	V	Q
3'	265	1.31	2.99	791 cfs.
4'	470		3.62	1701 "
5'	735	1.84	4.20	3087 "
6'	1058	2.08	4.74	5017 "



$$\text{Reach} = 2540$$

$$Q_1 = 4990; y_1 = 5.95'; A_1 = 1030; \text{Vol}_1 = \frac{1}{2} (1030) (2540) = 30 \text{ Ac. ft.}$$

$$Q_2 = 4990 \left(1 - \frac{30}{193}\right) = 4210 \text{ cfs.}; \text{Wave Ht.} \approx 5.6'; \text{Vel.} = 4.6 \text{ fps}$$

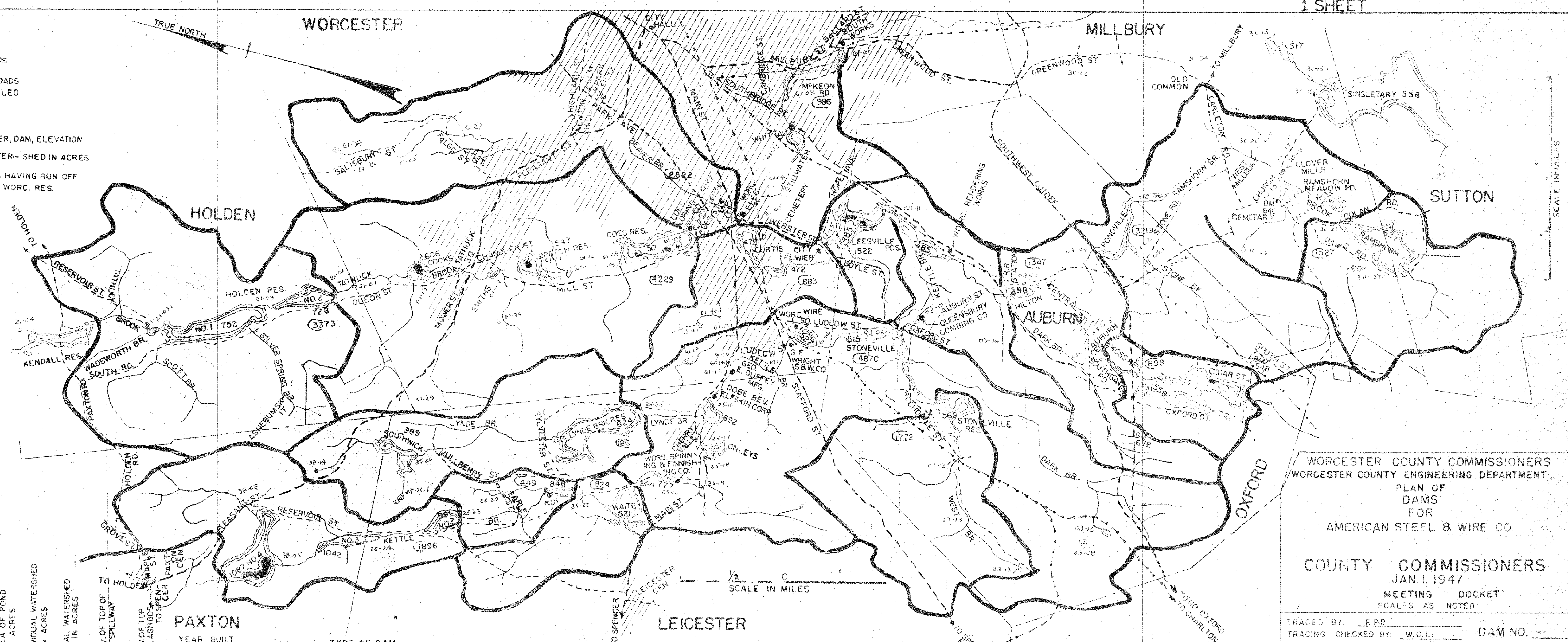
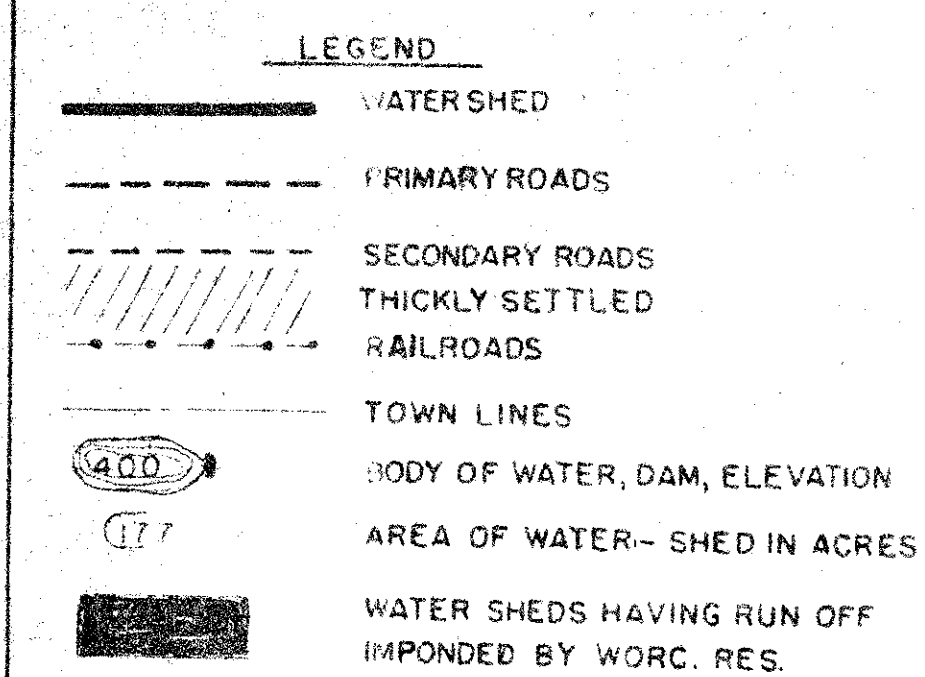
Time to Drain:

$$\frac{43560 (193 \text{ Af})}{3600 (\frac{1}{2}) (4210)} = \underline{1.1 \text{ Hours. or } 67 \text{ Minutes}}$$

Effect on Patch Res:

$$\text{Raise Level by } \frac{193}{640 (.05)} = \underline{6 \text{ feet}}$$

D-6



WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
DAMS
FOR
AMERICAN STEEL & WIRE CO.

COUNTY COMMISSIONERS
JAN 1, 1947
MEETING DOCKET
SCALES AS NOTED

TRACED BY: L.P.P.
TRACING CHECKED BY: W.O.L. DAM NO. 17720
COUNTY ENGINEER

POND NAME	CAPAC: IN MIL	AREA IN A	INDIVID IN A	TOTAL IN A	ELEV. OF DAM SP	ELEV. OF FLASH	YEAR BUILT		TYPE OF DAM	HIGH WATER MARK & WATER RIGHTS	YEAR ESTABLISHED	FLOW CONTROLLED BY	MISC INFORMATION	COUNTY ENGINEER	
							ORIGINAL DAM	PRESNT DAM							
CENTRAL WORKS *	5.3	5.3			443.40		1814	1899	EARTH MASONARY TIMBER CORE PLAN B 177 1899 REPAIRS 1936 PLAN 12718	ELEV 443.47 COPPER BOLT TOP OF STONE BOUND 11.5 SOUTH OF AND 155' W FROM S.E. COR. OF MILL FROM PLAN 3046 - BOUND IS SHOWN AS 60' UP STREAM FROM SPILL - WAY - PROP. PLAN - 8038	1873 BY SUPERIOR COURT DECREE VOL. 22 P. 127 WASHBURN MOEN MFG. CO. VERSUS CROMPTON CARPET CO. DEFENDANT	AMERICAN STEEL & WIRE CO.			
COES RESERVOIR *		119		4229								NO AGREEMENT - COES CO.			
CURTIS POND *	160	62	883	16663						ELEV 473.51, TWO FEET BELOW BOLT IN EAST CONCRETE WALL OF SPILLWAY, WORCESTER ELECTRIC LIGHT PLAN 1336 (WATER RIGHTS PURCHASED 1917 FROM HILTON HEIRS BK 2123 PAGE 253. PROPERTY PLAN 8034 HIGH WATER MARK	JAN 30, 1914 BY H.A. PRATT PRIV. ENG.	NEW ENG. POWER ASSOCIATES AM. S & W. CO. CAN OBTAIN WATER IN EMERG.	OLDEST WATER PRIVILEGE IN SYSTEM, WORC. COUNTY ELEC. LIGHT CO. USES 2 MIL. GAL. 24 HRS (1921) FOR CONDENSING, POND KEPT FULL		
HILTON POND	40	26.4	1347	6792	96.56	98.38		1939	GATE IS SCREW STEM 24" PIPE EARTH WITH CONCRETE CORE WALL PLAN FOR CORE - WALL 9642 - CONCRETE SPILLWAY PLAN 13530 - 31 10591 REPAIRS			AMERICAN STEEL & WIRE CO.			
LEESVILL POND	125		1522	15780								CONSOLIDATED RENDERING CO.	NECESSARY TO KEEP POND FULL FOR SUCTION OF THEIR PUMPS		
MOSS RESERVOIR	256	158	699	699	110.79	112.17	1921	1928	CONCRETE EARTH ADDED CONCRETE GRAVITY SECTION COVERED WITH EARTH GATE SCREW STEM, 30"x30" BOX OUTLET	ELEV. 112.05 BRASS PLUG IN LEDGE EAST SIDE OF POND, 208' SOUTH OF SPILLWAY CREST PLANS 14628 - SEE PLAN 8044 A FOR PARCIS PURCHASE - ALSO 8771 - 8777	OCT. 21, 1924 BY COUNTY COMM.	AMERICAN STEEL & WIRE CO.	DURING SUMMER MONTHS RESERVOIR LOSES 2" OF WATER WITHOUT DRAW DOWN		
PONDVILLE POND	125	45	2639	4746					STONE MASONARY			LAREE FABRICS MILLS INC. WE HAVE NO AGREEMENT	USED FOR CLEANING & CONDENSING PURPOSES NO POWER USE		
RAMSHORN POND	720	145	1527	1527	22.0	24.0	PREVIOUS TO 1831	1872-3	GATE SCREW STEM, 24" & OUTLET PIPE (POSSIBLY) 30" EARTH PUDDLED TO EITHER SIDE CHESTNUT CUTOFF WALL ALONG DAM & (1873) PLAN 13515 A & B.	ELEV. 24.29 IRON PIN IN LEDGE ON WESTERLY SHORE ELEV. OF N.W. COR. OF N.W. BRIDGE WING WALL - 30.00	1872 REG. OF DEEDS, BK. 875, P. 132-149 PURCHASED BY A. CURTIS AS TRUSTEE FOR RAMSHORN POND CO. PREVIOUS TO RAISING DAM	RAMSHORN POND ASS. - A.S. & W. CO. WORC. COUNTY ELEC. HOPEVILL MFG. CO. CONSOL. RENDERING, WHITTALL EL. ON BLACKSTONE RIVER (AM. S. & W. CO. DAY CLOVER, W. WINDLE)	MIN. FLOW REQ. BY SMALL MILLS WHEN IN OPERATION IS 6" THRU 36" WIDE WEIR - 2,500,000 GAL. DAY FROM H.W. CLOVER FLOW FROM 1904 TO 1939 NEVER HAS EXCEEDED 10' OVER SPILLWAY (USED FOR IMPONDING DURING RAINS & IN WINTER TO ENABLE CLOSING OF RAMS HORN POND GATE)	AMERICAN STEEL & WIRE CO. SUBSIDIARY OF UNITED STATES STEEL CORPORATION	
RAMSHORN MEADOW POND	22	38	580	2107				1916	GATE 36" & OUTLET EARTH WITH CONCRETE COREWALL, CONCRETE SPILLWAY PLAN 7171	PROPERTY MAP 8033		WHITTALL ASSOCIATES CALL ENG. RM FOR FLASH BD. CHANGE	USED FOR POWER WHEN PLENTY OF WATER OTHER USE IS FOR CLEANING		
STILL WATER POND *	35	30	605	2439					RACK PINON 2 CONCRETE 2	PROPERTY MAP 8769 (1904)		QUEENSBURY COMBING CO. NEW ENGLAND POWER ASSOCIATES PURCHASED IN 1945	THE AGREEMENT IS THAT QUEENSBURY COMBING CO. CAN DRAW SUFFICIENT WATER TO RUN PLANT. WE CAN OBTAIN WATER BY CONSULTING N.E. POWER CO.	ENGINEERING DEPARTMENT	WORCESTER MASS
STONEVILLE POND		45	4870	7466											
STONEVILLE RESERVOIR	185	68	1772	1772						PROPERTY MAP 8769 (1904)					
SOUTHGATE POND	1.5	1.5	83	782					GATE 30" & OUTLET EARTH & STONE WALL	FROM M. BONZEY 1917 BK. 2123, P. 290		AMERICAN STEEL & WIRE CO.	DAM WASHED OUT		
SOUTH WORKS POND *	20.0	130	381	24700	438.04	440.04		1891	FLOOD GATE - RACK & PINION, INTAKE GATE - SCREW STEM INSTALLED IN 1943 - MASONRY PLAN 3355 INTAKE 14454 A-H SECTIONS THU. POND 3265 (1906) 12792 (1936)	ELEV 443.47 SAME AS CENTRAL WORKS) ESTABLISHED IN EXCHANGE OF TITLES BETWEEN HOLY CROSS, AM. S. & W. CO. CITY OF WORCESTER AND P.F. & F.W. TAYLOR PROP. PLAN 8041	AP. 29, 1909 BK. 1904, P. 68 THIS IS (TAYLOR DEED)	AMERICAN STEEL & WIRE CO.	18,700,000 GAL. PER DAY REG. FOR SOUTH WORKS & WIRE MILL AS MEASURED IN 1942 PREPARATORY TO INTAKE CHANGES	DRAWN BY JAN. 1, 1947, BROUGHT SCALE 1" = 1/2 MILE 17720	

* RUN OFF FROM WATERSHED EFFECTED BY CITY STREETS AND STORM SEWERS
NOTE: THE INFORMATION SHOWN ON THIS PLAN WAS DRAWN EXISTING PLANS, & FROM FILES OF SUPT. OF ENG. & MAINT.
PARTICULARLY THE G.E. GOODRICH REPORT NOV. 14, 1921 AND "MOSS RESERVOIR" DATA CONCERNING ORIGINAL OWNERS OF CEDAR SWAMP
PLANS FOR MOSS RES. DAM: CONCRETE, ORIGINAL DAM 6510 TO 12, PRES. CONST. 10584, 10582-3, 10507 & S10400, S14628
PROPERTY, 1877, 8044A & LOTS PURCHASED IN CEDAR SWAMP 8771

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AND IS SUBJECT TO RETURN UPON DEMAND.

WATER SHED OF
SOUTHWORKS POND

DAM NOS. AS NOTED IN PLAN

WATERSHED PLAN
FIGURE D-1

APPENDIX E
INVENTORY FORMS